

## NEW SPECIES AND NOTES ON CALIFORNIA MAYFLIES

*(Ephemeroptera)*

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During the years 1948, 1949 and 1950, the writer and his wife, Helen L. Day, made numerous short expeditions, collecting Mayflies on the streams of northern California. Much of the area worked lies on the western slope of the Coast Range or above the 5,000 ft. level of the Sierra Nevada, where low temperatures after sundown make collecting at light unproductive. By collecting and rearing nymphs, however, it has been possible to make positive associations between nymph and adult. In the present paper several new species are described, and descriptions given for a few unknown nymphs or adults of known species. Also, drawings are supplied for several known species where additional detail seems desirable or necessary.

E. C. Van Dyke, E. S. Ross and Hugh B. Leech of the California Academy of Sciences have been most considerate in offering facilities and counsel based on their extensive experience. Mr. Leech has joined us on field trips and has been an unfailing source of encouragement and guidance.

Several years ago a fortunate acquaintance was made with George F. Edmunds, Jr., of the University of Utah. Mr. Edmunds has given most generously of his time and wide knowledge of the Ephemeroptera; he has supplied many comparison specimens, checked identifications and descriptions, and made generally available his understanding of this group.

Through the kindness of Henry Dietrich and W. J. Brown, numerous loans of specimens from the Cornell University collection and the Canadian National collection respectively, have been made available to me for comparison purposes. A suggestion from Robert L. Usinger of the University of California resulted in securing the fine illustrations given as part of this paper; they were drawn at the British Museum (Natural History) by Arthur Smith.

***Paraleptophlebia helena* Day, new species**

(Plate I)

Male imago (in alcohol)

*Head:* Piceous with yellow brown stripe on vertex. Clypeus yellow brown. Compound eyes contiguous, upper portions pale orange and lower portions black. Ocelli milky white. Basal segments of antennae yellow brown; filaments smoky with white tips. *Thorax:* Pronotum medium black brown. Me-

sonotum deep red brown with anterior portion and postero-lateral areas black brown; wide pale band anterior to scutellum, and bordered laterally with pale yellow. Metanotum smoky, scutellum yellow. Sternum red brown with wide yellow band across prosternum. *Legs*: Coxae and trochanters of all legs pale brown with blackish markings. Foreleg uniformly yellow brown with black femoro-tibial joint. Middle and hind legs somewhat paler. All claws pale. *Wings*: Entirely suffused with deep red brown. Subcosta and costal brace of forewing pale yellow brown; all other veins of both wings well defined and dark brown. *Abdomen*: Tergite 1 opaque medium brown with black posterior margin. Tergites 2-7 with one-fifth to one-third in anterior portion hyaline; vague wide median hyaline stripe bordered on each side with submedian black lines; posterior halves of tergites 2-7 with large, pale, almost hyaline areas, one on each side, bordered with black brown; postero-lateral areas surfaced with black. Segments 8-10 opaque orange yellow. All tergites with black posterior margins. Sternites 2-7 semi-hyaline and pale red brown with anterior margins hyaline; a pair of short, oblique hyaline dashes on each sternite. Pleural fold broadly hyaline with wide, dark geminate line above. Black dot on spiracles of segments 2-7. Small black U-shaped mark on each tergite just above geminate line, opening forward. *Genitalia*: Forceps opaque yellow in basal third of long segment; remainder smoky. A large lobe at base of first segment of forceps. *Tails*: Dark brown, narrowly black at each joining. *Size*: Body 9 mm. long; forewing 9.5 mm.; tails 13.5 mm.; foreleg 11 mm.

Female imago (in alcohol)

*Head*: Yellowish-white with extensive black markings; black dashes from anterior end of median carina to each lateral ocellus; wide black W-shaped mark based on median ocellus and encompassing lateral ocelli; frontal margin dark brown. Ocelli white. Compound eyes black and widely separated. *Thorax*: Mesonotum yellow brown with pale areas anterior to and laterad of scutellum; antero-lateral margins narrowly white. Metanotum yellowish-white with blackish posterior margins. *Legs*: As in male imago, slightly paler. Coxae and trochanters marked with black. *Wings*: As in male imago. *Abdomen*: All segments opaque; ground color pale yellow, widely marked with thin black surfacings. Tergites 2-7 with narrow anterior and wide posterior pale margins except for blackish areas in postero-lateral corners. Also, at each postero-lateral margin, a strong black line crosses pleural fold, extending one-third the distance up toward median line of tergite, and one-quarter the distance down toward median line of sternite; joined to this line is another, extending at right angles along the pleural fold about one-third the distance toward anterior margin. Narrow median pale stripe on tergites bordered on each side by wider dark line. Tergite 10 largely dark. Sternites somewhat paler than ground color of tergites, with central portion of posterior margins pale. Ganglionic areas of sternites pale; sternites 1-7 each with a pair of short, pale submedian dashes near anterior margin. Posterior margin of sternite 7 thickened and immediately beyond the opening of the egg valve is a large, circular brown median spot on sternite 8. Pleural fold as in male. Spiracles marked with a black L-shaped mark. Emargination of subanal plate shallow. *Tails*: Dark brown, narrowly darker at joinings. *Size*: Body and forewing of ♀ imago 0.5 mm. longer than ♂ imago.

## Nymph (in alcohol)

*Head*: Vertex whitish from straight posterior margin of head to lateral ocelli; a wide black V-shaped mark from the black compound eyes to median ocellus; in front of median ocellus a wide white quadrangle, bordered on anterior and lateral edges by a narrow black line. Frontal and lateral margins of head semi-transparent red brown. Antennae 3 mm. long; the two basal segments dark brown, with filaments smoky. A pair of smooth, ivory colored, pointed and incurved mandibular tusks extend forward from head 1.2 mm. *Thorax*: Pronotum yellowish-white, broadly marked with red brown in anterior and lateral portions. In the mature nymph the scutum of the contained subimago is clearly seen as a black bordered dark brown area with wide white median stripe widened into white circular areas at each end. Sclerites of sternum red brown, sutures white. *Legs*: All femora and tibiae yellow white. Femora with large brown spot on frontal edge one-quarter distant from apical end. Tibiae with wide dark brown subapical bands; femoro-tibial joints dark brown. All tarsi brown, darker in the basal half. Claws of foreleg with 22 to 26 denticles. *Abdomen*: Dorsum with pale yellow pattern showing through thin surfacing of black as shown in Plate I, fig. 4. Sternites light yellow with narrow black anterior margins. Lateral extensions of all segments margined with black. *Gills*: Bifid narrowly lanceolate, largest on segments 2-6, smaller on 7, and quite small on 1. Gills divided very close to base; tracheae without branchlets. *Tails*: Pale, with whorls of minute spines and longer hairs at each joining. *Size*: Body 9.5 mm. long; tails 8 mm.

*Holotype*: Male imago; collected by Helen L. Day on MILL CREEK, VENADO ROAD, SONOMA COUNTY, CALIFORNIA, in October, 1949; in collection of the California Academy of Sciences. *Allotype*: Female imago; same data; in collection of California Academy of Sciences. *Paratypes*: 2 ♂ imagoes, 2 ♀ imagoes, 2 nymphs in collection of California Academy of Sciences; 1 ♂ imago, 1 ♀ imago, 1 nymph in collection of G. F. Edmunds, Jr., 21 ♂ imagoes, 5 ♀ imagoes, and 35 nymphs in author's collection.

The male adult of *P. helena* is distinguished from other *Paraleptophlebia* spp. having nymphs with tusked mandibles, by the deep brown wings. From *P. zayante* (see below), *P. helena* can be separated also by the slimmer abdomen and legs and greater delicacy of the parts of the latter. The nymph of *P. helena* has longer and straighter mandibular tusks than those of *P. zayante*. The emargination of the subanal plate of the female adult of *P. helena* is shallow and semi-circular, while that of *P. zayante* is more deep and narrow.

The nymph was found only on well-aged leaves in quiet, shoal portions of a rapid, small spring-fed stream having a temperature of 48-50° F. Mating flight of the adults begins about one hour before sunset. Association of nymph and adult was established through rearing.



**Paraleptophlebia zayante** Day, new species

(Plate II)

Male imago (in alcohol)

*Head*: Black brown with frontal shelf hyaline; median carina, basal sclerite of antennae and dot on vertex, pale yellow. Ocelli white. Compound eyes contiguous; upper portion pale orange and lower portion black. *Thorax*: Pronotum dark red brown with black markings at postero-lateral corners. Mesonotum medium brown with narrow black lateral margins; median and submedian sutures and large postero-lateral areas, pale yellow; scutellum dark brown, anterior to this, a large pale area. Metanotal scutellum pale with narrow dark brown posterior margin. Sternum pale yellow brown. *Legs*: Uniformly light red brown with tarsi darker. Femoro-tibial joint black. *Wings*: Faintly milky white very lightly tinted with palest brown in stigmatic area of forewing. Long veins of forewing and hindwing pale yellow brown, becoming lighter toward rear margins. Crossveins of forewing very fine and pale brown, becoming lighter toward rear margin. Crossveins of hindwing light brown from costa to  $R_1$ , others colorless. *Abdomen*: Segments 1, 8 and 9, and posterior half of 7 opaque. Tergites 2-6 hyaline yellow patterned with a thin surfacing of black; anterior margins are clear hyaline and posterior margins hyaline yellow; narrow hyaline median stripe bordered by wide submedian black lines; laterad of these black lines are wide hyaline lines; laterad of these hyaline lines are large dark areas with a pale area in the center of each. Pleural fold marked for its entire length by a broad, faint dark line. Each spiracle marked with a black dot. The postero-lateral corner with a short, dark line extending upward, and another as short extending forward. Sternites 2-7 hyaline yellow, each with a well-defined central dark brown ganglionic area; a pair of dark dots on each sternite. *Genitalia*: Forceps deep golden brown at base, paling distally; large lobe at base of first segment. Reflex spurs present on penes. *Tails*: Bright red brown entire length, narrowly pale at each joining. *Size*: Body 10 mm. long; forewing 10 mm; tails 12.5 mm.; foreleg 10 mm.

Female imago (in alcohol)

*Head*: As in male except compound eyes are small and widely separated. A wide chalky white band across the occipital region from eye to eye. *Thorax*: Notum and sternum as in male, slightly darker. *Legs*: As in male, slightly darker. *Wings*: Clear hyaline. Stigmatic area of forewing brown tinted. All veins of both wings as in male, slightly coarser and darker. *Abdomen*: Segments 1-7 pale red brown, translucent; 8-10 opaque. Tergites heavily surfaced with black wash; maculation same as male. Sternites as in male except that ganglionic areas are outlined only in dark brown. *Tails*: As in male imago, darker. *Size*: Body 10 mm. long; forewing 11.4 mm.; tails 12.5 mm.; foreleg 6 mm.

Nymph (in alcohol)

*Head*: Heavily washed with blackish-brown, a pale area below median ocelli; entire vertex pale. The two basal segments of antennae pale smoky; filaments yellow. A pair of smooth, yellowish, strongly incurved tusks of the mandible extend forward beyond the head. *Thorax*: Notum yellowish, mottled with black. Sternum yellowish, each of the three segments strongly marked



with large black ganglionic area. *Legs*: All segments yellowish-white, each widely banded with brown; femoro-tibial joints dark brown. 18-22 denticles on fore claw. *Abdomen*: Tergites show pale yellow pattern through surfacing of black, as shown in Plate II, fig. 5. Sternites pale, widely washed with black close to lateral margins, each with black ganglionic area. *Gills*: Bifid, lanceolate and divided to base; tracheae black, short and scattered. *Tails*: Pale, joinings narrowly black. *Size*: Body 10 mm. long; tails 9 mm.

*Holotype*: Male imago; collected by the author on ZAYANTE CREEK, SANTA CRUZ COUNTY, CALIFORNIA during October, 1950; in the collection of the California Academy of Sciences. *Allotype*: Female imago; same data; in collection of California Academy of Sciences. *Paratypes*: All topotypical: 2 ♂ imagoes and 2 ♀ imagoes in collection of California Academy of Sciences; 1 ♂ imago, 1 ♀ imago, 1 nymph in collection of G. F. Edmunds, Jr.; 7 ♂ imagoes, 5 ♀ imagoes and 15 nymphs in author's collection; all collected in October, 1950.

The male adult of this new species is distinguished from the closely related *P. helena* by the pale wings, as well as the genitalia; the prominent dark ganglionic marks of the sternum are completely lacking in *P. helena*. The mandibular tusks of the mature nymph of *P. zayante* compared to those of *P. helena* are one-third shorter, and are heavier and more curved. Nymphs were found in quieter water of running stream, on leaves and branches. Nymphs were intermingled with those of *P. debilis* Walker only, the latter being much more numerous. Association of nymph and adult was established through rearing.

#### ***Paraleptophlebia quisquilia* Day, new species**

(Plate IV, figures 6, 7)

Male imago (in alcohol)

*Head*: Pitchy dark brown with yellow median carina. Clypeus yellow hyaline with anterior edge black brown. Vertex with wide full-length median brown stripe. *Thorax*: Pronotum smoky marked with brown; anterior margin black. Mesonotum reddish black brown with black sutures and margins; somewhat paler before the scutellum. *Legs*: All coxae dark red brown with black pencilings. Fore femur and tibia pale red brown. Femora and tibiae of legs 2 and 3, palest yellow. All tarsi white. *Wings*: Vitreous. Long veins of forewing faintly marked with gray, those toward hind margin becoming paler. Subcosta of hindwing gray; all other veins of both wings pale. *Abdomen*: Tergites 2-7 hyaline yellow, thinly washed with black; dark, poorly marked triangles in antero-lateral areas; posterior margins each with a thin, sharp black line; from each postero-lateral corner a narrow black line extends forward above pleural fold a very short distance, then runs obliquely upward half way to anterior margin. Segments 8-10 same color as mid-sections, but opaque. Sternites 1-7 each with a pair of submedian oblique hyaline dashes

starting from anterior margins, and each with a pair of submedian hyaline small spots. *Tails*: Smoky yellow, narrowly darker at joinings. *Size*: Body 6.3 mm. long; forewing 7 mm.; tails 12 mm.; foreleg 6 mm.

Female imago (in alcohol)

*Body*: Color uniformly pale yellow brown, tergites very lightly surfaced with black. *Legs*: Foreleg pale yellow, femur faintly smoky and with black hair-lines extending almost full length of segment; one hair line central on anterior surface and the other marking the dorsal edge. Legs 2 and 3 white, tarsi smoky. Fore tarsus black, contrasting strongly with other leg segments. *Size*: Body 6.7 mm. long; forewing 7 mm.; tails 12 mm.

Nymph (in alcohol)

*Head*: Pale yellow with labrum and fronto-clypeal area dark red brown; area between ocelli and lateral margins widely dark. *Thorax*: Pale yellow, lightly washed with black. *Legs*: Pale, all segments light brown in the middle. Coxae largely light brown. Claws yellow, fore claw bearing 16 denticles. *Abdomen*: Tergites 2-7 with conspicuous small submedian pale areas at anterior margin; starting at the edge of these pale spots, a wide, curved dark stripe joins posterior margin just above postero-lateral corner; posterior margins of all tergites broadly dark. Tergites 8-10 pale with some dark markings. Sternites pale yellow with posterior margins faintly dark across the median section, these becoming strongly dark as they approach the lateral margins. Segments 8 and 9 bear postero-lateral spines. *Gills*: Broadly lanceolate, divided almost to the base. Tracheae black and without branchlets. *Tails*: Yellow, unmarked at joinings. *Size*: Body 6 mm. long; tails 9 mm.

*Holotype*: Male imago; collected on MIDDLE CREEK, LAKE COUNTY, CALIFORNIA, May 28, 1949; in collection of California Academy of Sciences. *Allotype*: Female imago; same data; in collection of California Academy of Sciences. *Paratypes*: Two ♂ imagoes, 3 ♀ imagoes and 4 nymphs in author's collection. Same data as holotype.

The association of nymph and adult was established through rearing.

This species is the smallest *Paraleptophlebia* found to date in California. Adult males cannot go beyond couplet 12 in Traver's key to the species of *Paraleptophlebia* (1935. Biology of Mayflies, p. 512), as the tails are not ringed at the base. However, the tails of *P. californica* Traver often lack rings at the base, and *P. quisquilia*, the new species, might be considered closest in relationship to *P. californica*; apart from the differences in maculation, the difference of form of the genitalia of the two species serve to separate them. The cleft between the penes of *P. californica* is notably deep and wide, while that of *P. quisquilia* is very small by comparison. The type locality is 4.5 miles upstream, by road, from the town of Upper Lake.

**Ameletus imbellis** Day, new species

(Plate V, figures 2, 5 and 5a)

Male imago (in alcohol)

*Head:* Face and clypeus black brown; median carina light brown; vertex pale. Ocelli milky white ringed with black at base. Compound eyes nearly contiguous; no oblique band across eyes, but lower portions darker gray and with smaller facets. *Thorax:* Pronotum black brown with wide anterior and fine posterior and lateral pale margins. Mesonotum yellow brown with extensive darker lateral areas; anterior portion, scutellum and median suture, dark brown; two pale dots before the scutellum. Metanotum pale brown. Pleural sutures white; sclerites red brown; a wide black line runs obliquely downward from root of forewing. Sternum darker red brown than sclerites of pleuron. *Legs:* All coxae pale brown, with dark brown markings; narrowly margined with black. Fore trochanter and femur dark brown. Fore tibia and tarsus pale brown. Middle and hind legs pale yellow; joinings of tarsi narrowly black. *Wings:* Faintly milky, strongly so in stigmatic area of forewing. All veins in both wings medium brown, a few crossveins of forewing lightly clouded with brown; humeral brace dark brown. *Abdomen:* Segments 1, 8, 9 and 10 opaque dark brown. Segments 2 and posterior half of 7, translucent medium brown. Tergites 3-6 are hyaline white with thin, broad dark brown surfacing in median and posterior areas; posterior margins widely pale. Sternites 2-7 hyaline yellow white with faint indications of darkened ganglia; on sternite 2, a pair of large dark brown median spots near anterior margin. *Genitalia:* Stimuli sharp and fine. Second joint of forceps bent strongly inward near base. *Tails:* Light brown, joinings pale. *Size:* Body 12 mm. long; forewing 11 mm.; tails 15 mm.; foreleg 10.5 mm.

Female imago (in alcohol)

*Description:* Considerably darker than male imago. Notum concolorous dark brown. Tergites patterned as in male; dark areas more extensive and purple in tone. Sternites 2-7 hyaline pale purple-rose. Ovipositor very prominent and black in middle. Wing veins thicker and darker than in male imago; crossveins more heavily clouded; humeral brace black brown. *Size:* Body 10 mm. long; forewing 10.5 mm.; tails 14 mm.

Nymph

Features of the nymph that can be determined from the cast skin show tails widely banded with dark in the middle area. Gills with short chitinous band about one-quarter distant from the dorsal edge.

*Holotype:* Male imago; collected on SAGE CREEK, NAPA COUNTY, CALIFORNIA, April 4, 1950; in collection of California Academy of Sciences. *Allotype:* Female imago; same data; in collection of California Academy of Sciences. *Paratypes:* 3 ♂ imagoes from Sage Creek April 4, 1950; 10 ♂ imagoes and 8 ♀ imagoes from Sage Creek, March 18, 1951; 5 ♂ imagoes and 7 ♀ imagoes from Little Stoney Creek, Colusa County, California, April 21, 1951; 1 ♂ imago; 1 ♀ imago; 1 nymph in collection of G. F. Edmunds, Jr.; others in author's collection.



This species is very close to *A. amador* Mayo, but can be distinguished from the latter by the much sharper inward bend of the second segment of the forceps. The holotype of *A. amador* and 3 additional paratype ♂ imagoes loaned by Dr. Mayo show the second segment of the forceps to be smoothly and evenly curved exactly as illustrated in her paper (1939:151). The appearance of the sharp inward bend of the second segment of the forceps of *A. imbellis* is constant in 20 ♂ imagoes collected from two different locations in two separate years.

***Ameletus facilis* Day, new species**

(Plate V, Figures 6 and 6a)

Male imago (in alcohol)

*Head*: Velvety black brown with small pale spot before lateral ocelli and fine white circular line around antennal sclerite; narrow pale line on upper edge of median carina. Compound eyes dark gray, darker in lower portion and contiguous above. *Thorax*: Pronotum velvety black brown with fine white line on posterior margin and small white areas in postero-lateral corners. Mesonotum pale yellow brown with dark shading laterally and in postero-lateral areas; scutellum yellow brown narrowly margined with black brown; post-scutellum dark brown. Metanotal scutellum as in mesonotum. *Legs*: Foreleg dark brown; tarsus only a shade lighter than other joints. Legs 2 and 3 pale yellow; coxae pale, widely marked with brown and edged with black; coxal processes mostly dark brown. *Wings*: Vitreous. Stigmatic area of forewing strongly brown tinted. Brown spot at base of forewing. All veins of both wings amber; humeral braces amber. *Abdomen*: Segments 1, 8, 9 and 10 opaque brown. Tergites 2-7 semi-hyaline palest cream with smoky areas on posterior third, somewhat darker in postero-lateral corners. Tergite 2 almost entirely pale, with following tergites progressively more broadly darkened, 7 being almost entirely dark brown. Sternites 2-7 semi-hyaline white with opaque white ganglionic areas. Short, faint central submedian brown dashes on sternites 1 and 2. *Tails*: Pale yellow brown, the paler joinings of each section narrowly margined with dark brown. *Size*: Body 10.5 mm. long; forewing 10.5 mm.; tails 14 mm.; foreleg 9 mm.

*Holotype*: Male imago; collected on SAGE CREEK, NAPA COUNTY, CALIFORNIA, April 22, 1950; in collection of California Academy of Sciences. *Allotype*: Female imago; collected on Smith Creek, Santa Clara County, California, April 7, 1951; in collection of California Academy of Sciences. *Paratypes*: 1 ♂ imago and 1 ♀ imago, same data as holotype, in collection of California Academy of Sciences; 1 ♂ imago, 1 ♀ imago, 1 nymph, same data as holotype, in collection of G. F. Edmunds, Jr.; 10 ♂ imagoes and 9 ♀ imagoes from Smith Creek, April 7, 1951, in author's collection. Males key to *Ameletus* (1935:447), and *A. facilis*, n. sp. is closely related to

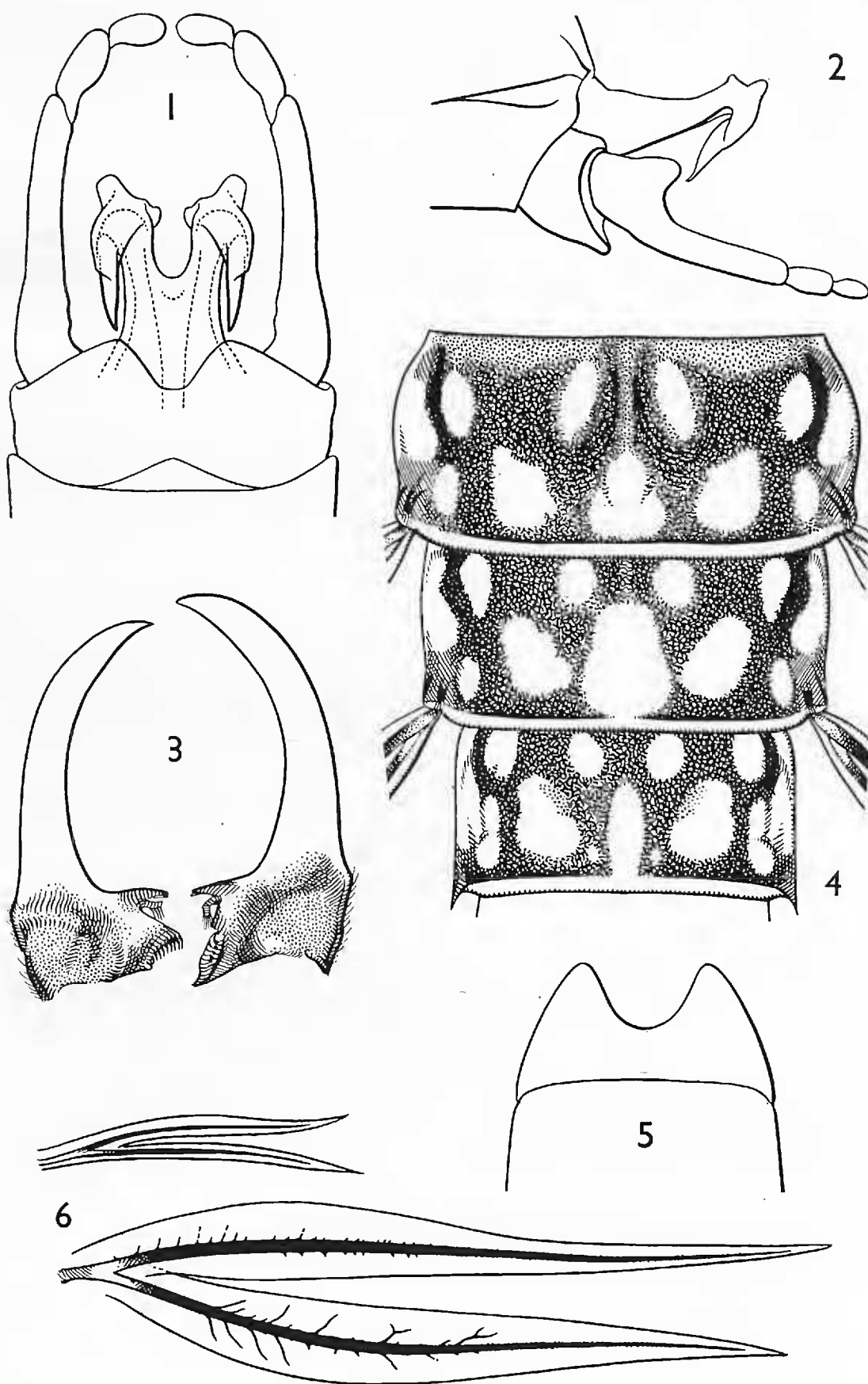
PLATE I, *Paraleptophlebia helena*

Fig. 1 genitalia, ventral aspect. Fig. 2 genitalia, lateral aspect. Fig. 3 mandibles of nymph. Fig. 4 tergites of nymph, 6, 7 and 8. Fig. 5 subanal plate, female imago. Fig. 6 gills of nymph, 1 and 4.

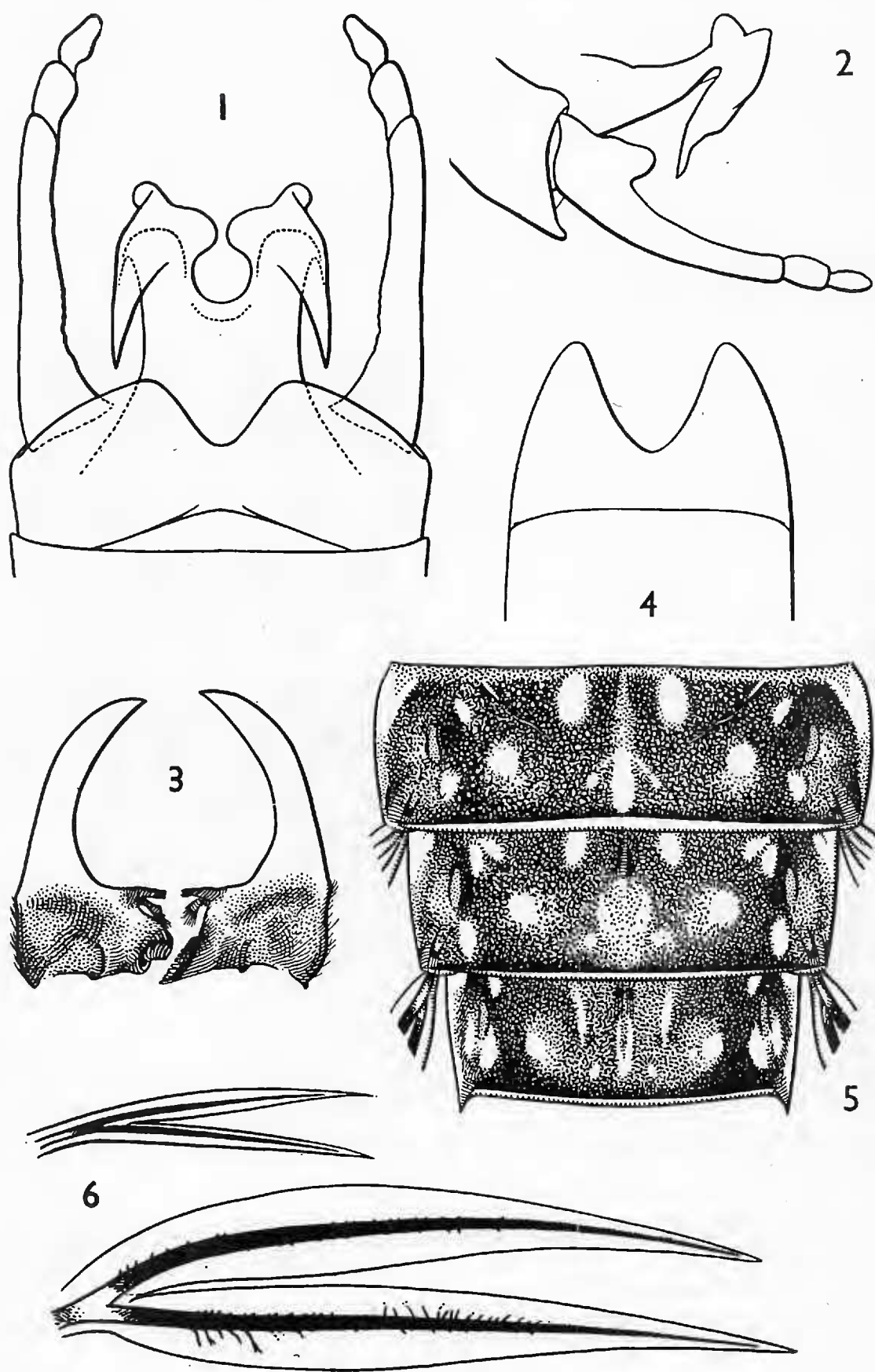


PLATE II, *Paraleptophlebia zayante*

Fig. 1 genitalia, ventral aspect. Fig. 2 genitalia, lateral aspect. Fig. 3 mandibles of nymph. Fig. 4 subanal plate, female imago. Fig. 5 tergites of nymph, 6, 7 and 8. Fig. 6 gills of nymph, 1 and 4.



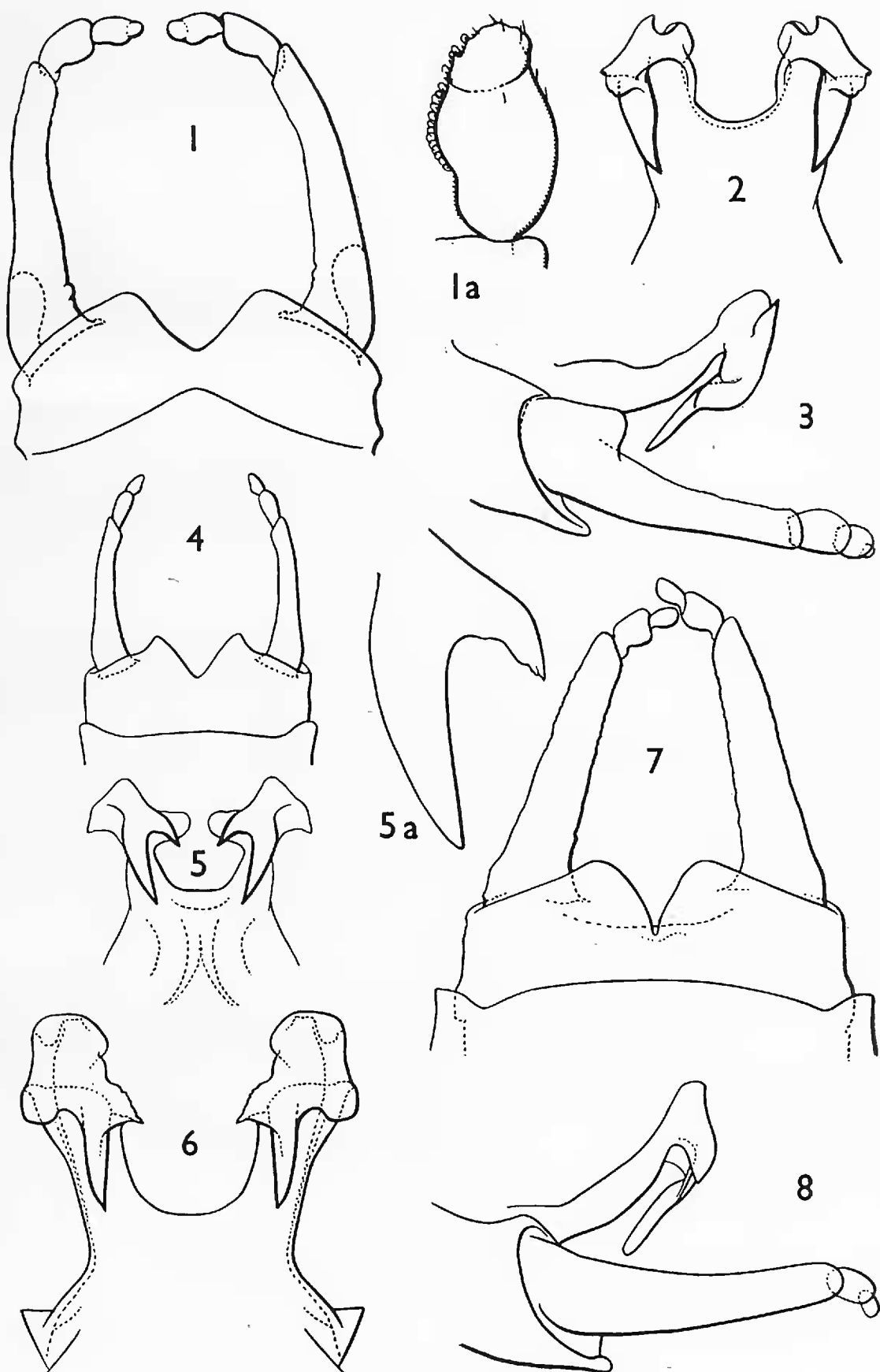
PLATE III, Genus *Paraleptophlebia*

Fig. 1 *P. packii*, forceps, ventral aspect. Fig. 1a *P. packii*, terminal joint of forceps. Fig. 2 *P. packii*, penes, ventral aspect. Fig. 3 *P. packii*, genitalia, lateral aspect. Fig. 4 *P. bicornuta*, forceps, ventral aspect. Fig. 5 *P. bicornuta*, penes, ventral aspect. Fig. 5a *P. bicornuta*, reflex spur. Fig. 6 *P. californica*, penes, ventral aspect. Fig. 7 *P. californica*, forceps, ventral aspect. Fig. 8 *P. californica*, genitalia, lateral aspect.

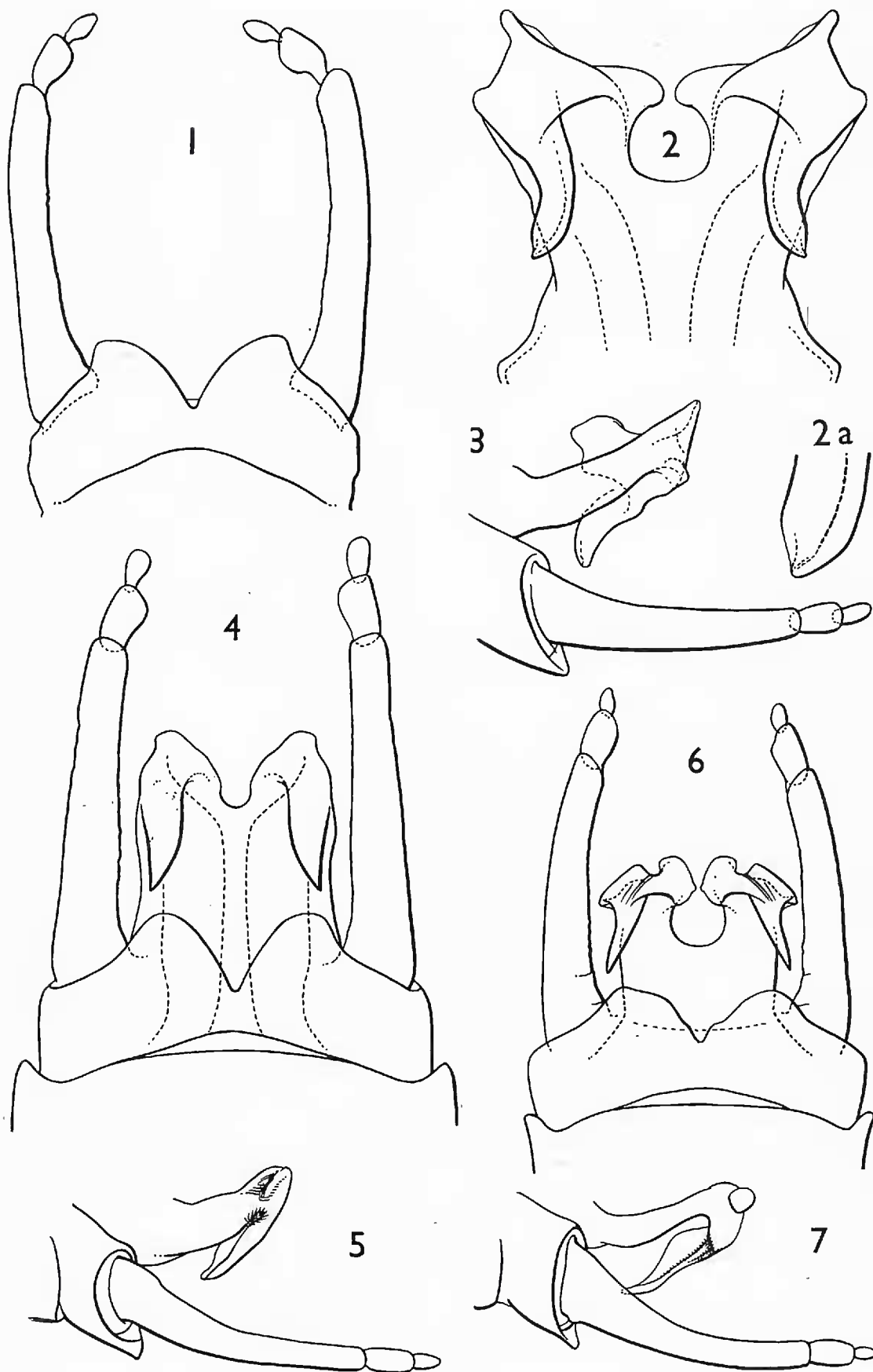
PLATE IV, Genus *Paraleptophlebia*

Fig. 1 *P. associata*, forceps, ventral aspect. Fig. 2 *P. associata*, penes, ventral aspect. Fig. 2a *P. associata*, tip of reflex spur. Fig. 3 *P. associata*, genitalia, lateral aspect. Fig. 4 *P. genitalia*, ventral aspect. Fig. 5 *P. clara*, genitalia, lateral aspect. Fig. 6 *P. quisquilia*, genitalia, ventral aspect. Fig. 7 *P. quisquilia*, genitalia, lateral aspect.

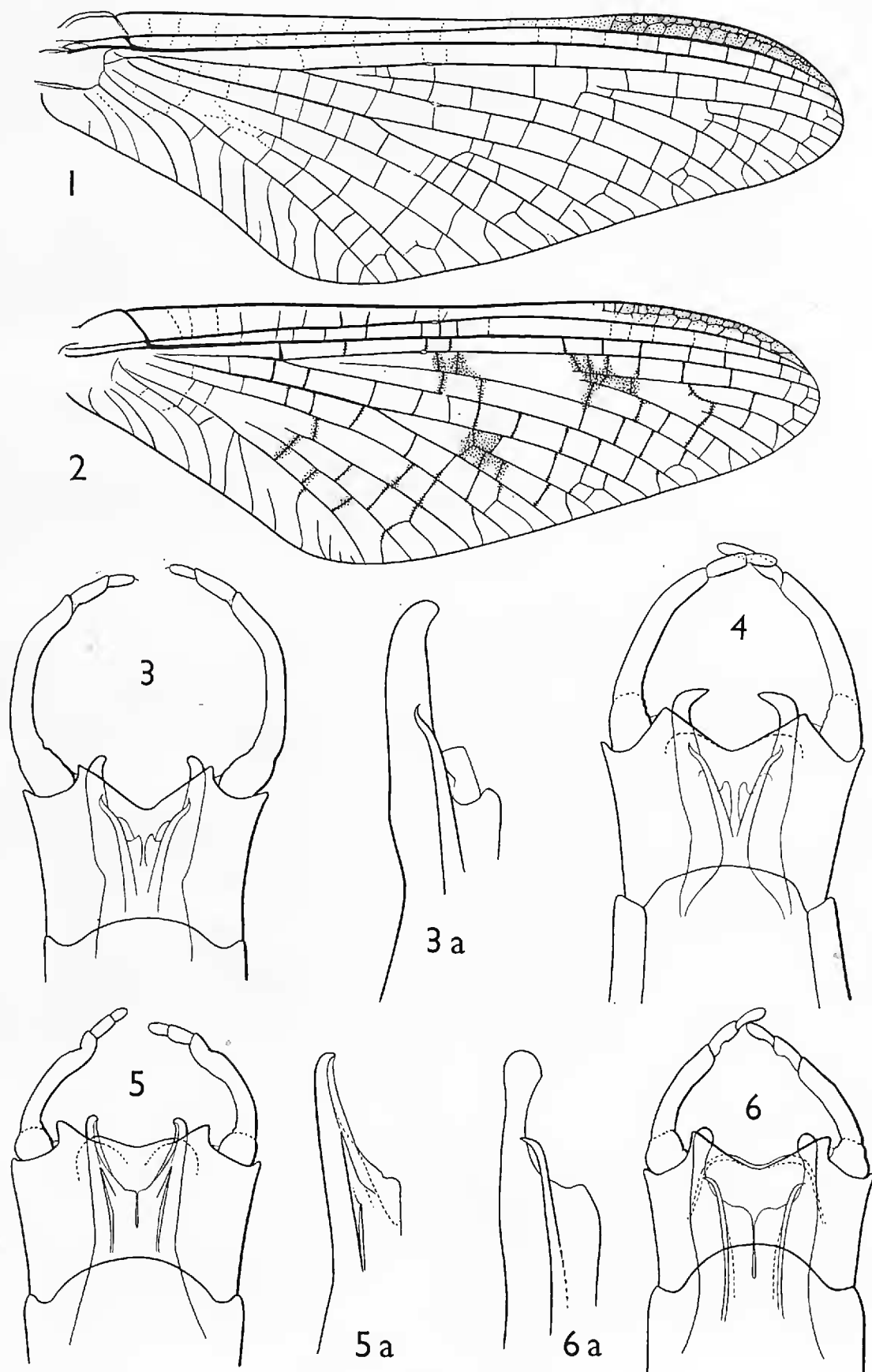
PLATE V, Genus *Ameletus*

Fig. 1 *A. dissitus*, forewing, male imago. Fig. 2 *A. imbellis*, forewing, male imago. Fig. 3 *A. dissitus*, genitalia, ventral aspect. Fig. 3a *A. dissitus*, penes, lateral aspect. Fig. 4 *A. dissitus*, genitalia, ventral aspect, showing distorted penes. Fig. 5 *A. imbellis*, genitalia, ventral aspect. Fig. 5a *A. imbellis*, left half of penes, ventral aspect. Fig. 6 *A. facilis*, genitalia, ventral aspect. Fig. 6a *A. facilis*, left half of penes, ventral aspect.



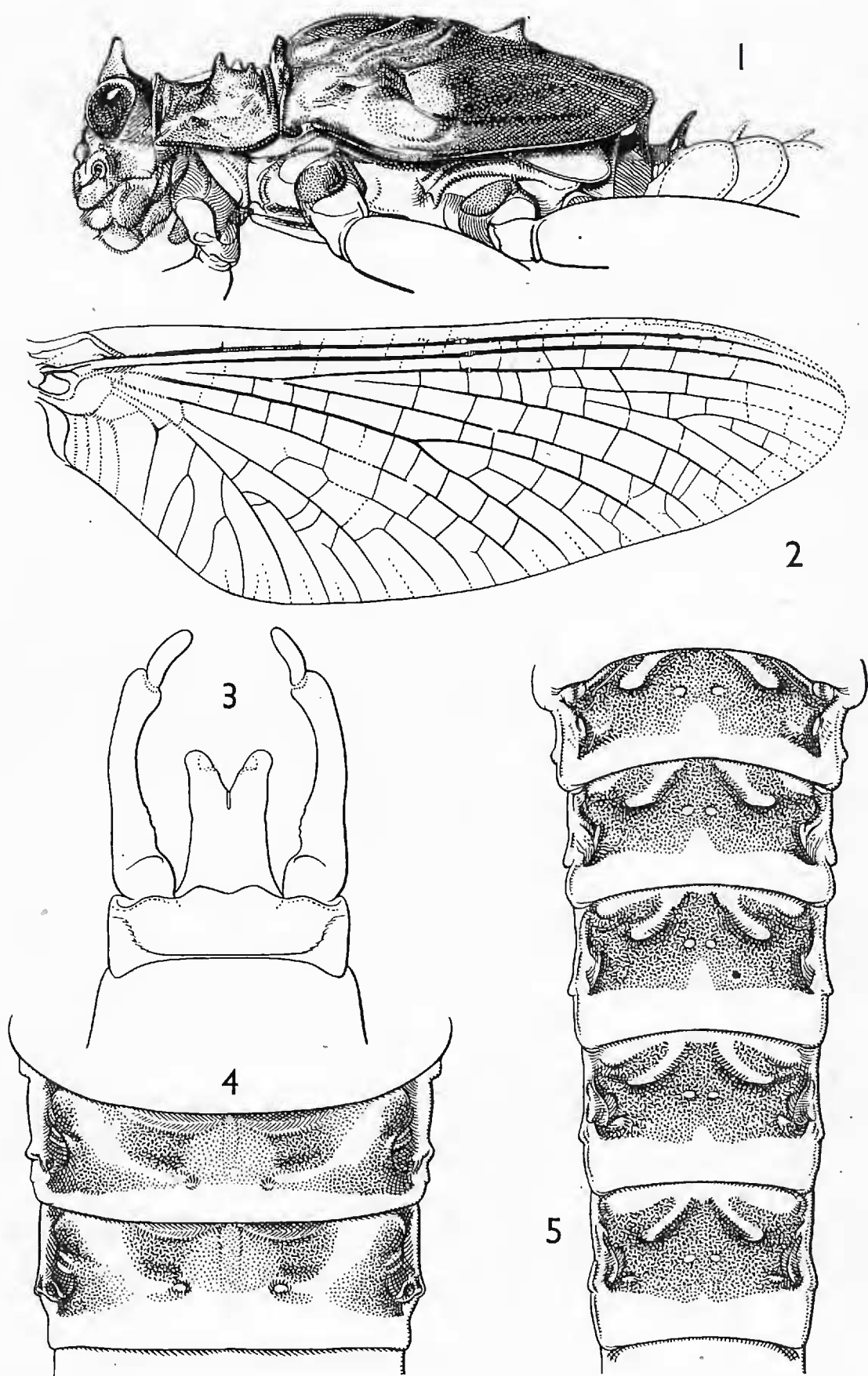
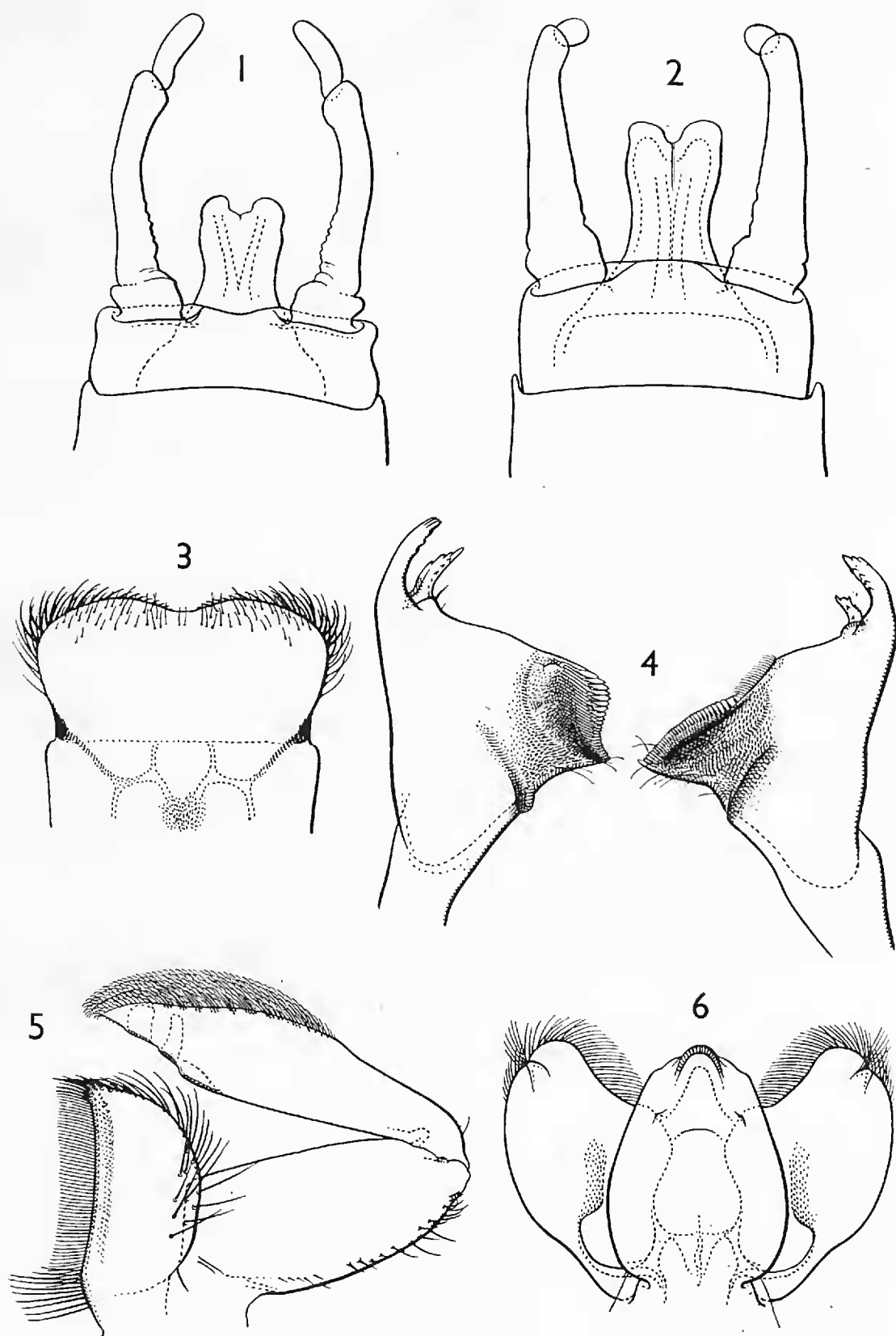
PLATE VI, *Ephemerella glacialis carsona*

Fig. 1 nymph, head and thorax, lateral aspect. Fig. 2 forewing, male imago. Fig. 3 genitalia, ventral aspect. Fig. 4 tergites of male imago, 2 and 3. Fig. 5 sternites of male imago, 2, 3, 4, 5 and 6.



## PLATE VII

Fig. 1 *Ephemerella spinifera*, genitalia, ventral aspect. Fig. 2 *Ephemerella cognata*, genitalia, ventral aspect. Fig. 3 *Ironodes lepidus*, labrum of nymph. Fig. 4 *Ironodes lepidus*, mandibles of nymph. Fig. 5 *Ironodes lepidus*, maxilla of nymph. Fig. 6 *Ironodes lepidus*, hypopharynx of nymph.

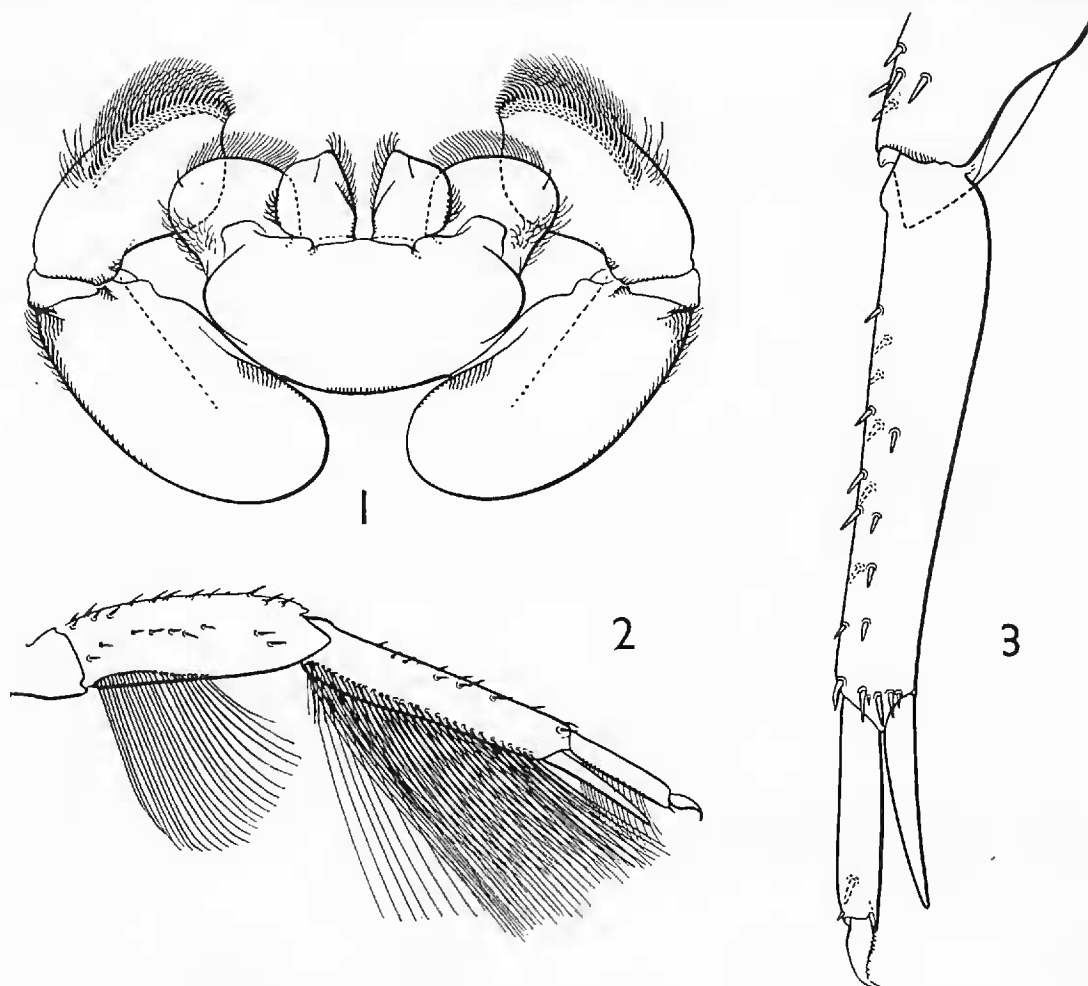


PLATE VIII

Fig. 1 *Ironodes lepidus*, labium of nymph. Fig. 2 *Isonychia velma*, foreleg of nymph. Fig. 3 *Isonychia velma*, fore tibia and tarsus of nymph.

*A. aequivocus* McDunnough. From the latter species, *A. facilis* may be distinguished by details of the genitalia. Comparatively, the penes of *A. facilis* are widely separated and clubbed at the apices; the stimuli are bent outward at right angles at the tips.

### *Ephemerella glacialis carsona* Day, new subspecies

(Plate VI)

Male imago (in alcohol)

*Head*: Dark yellow brown with black spots in front of compound eyes; a fine pale median line on vertex bordered on each side by narrow black lines; ridge of median carina black. Clypeus hyaline brown, emarginated with deep V-shaped notch at center. Light brown antennae set in white circles at base. Ocelli milky white, black at bases. Eyes nearly contiguous, upper portion pale yellow and lower portion black. *Thorax*: Pronotum dark yellow brown with median raised ridge finely black. A thin black lateral ridge halfway between margins extends almost entirely across the breadth of the segment. Mesonotum red brown, paler on sides; scutellum edged with black, with narrow median double black line extending forward from tip, and large median pale area anterior to end of this double line. Pleural sclerites dark brown, unsclerotized portions widely pale yellow. Sternum somewhat darker red brown than mesonotum. *Legs*: Foreleg red brown, basal third



of femur and tarsus paler. Middle and hind legs creamy, apical halves of femora ruddy brown. All coxae creamy with limited brown markings, each coxa reinforced strongly with a high, chitinous ridge extending its full length. Fore trochanter brown, others pale. *Wings*: Hyaline. Stigmatic area of forewing clouded and faintly brown. Wing veins strong red brown except that the crossveins between Costa and  $R_1$  are entirely pale, with those in the apical quarter of the forewing faintly brown in this narrow strip. The intercalaries of the forewing are pale brown and those of the hindwing mostly colorless. Long veins of the forewing are pale at the base, as is the costal vein of the hindwing. Crossveins of stigmatic area of forewing irregularly anastomosed. *Abdomen*: Deep ruddy widely marked with creamy white, sternites slightly darker. A wide creamy line extends the full length of the pleural fold. Wide creamy posterior margins of each segment give the abdomen a strongly marked annulate appearance. Tergites 1-8 have similar patterns, and are as shown in Plate VI, fig. 4. Tergite 9 ruddy with pale lateral and posterior margins. Sternites as shown in Plate VI, fig. 5. *Genitalia*: Styliger plate, penes and first two joints of forceps blackish brown with apical joint paler. *Tails*: Deep ruddy brown at base, paling to white at tips; joinings darker in dark portion only. *Size*: Body 18 mm. long; forewing 18 mm.; tails 21 mm.; foreleg 13 mm. Percentage of parts to total length of foreleg: femur, 29.3; tibia, 33.2;  $T_1$  12.2;  $T_2$  12.2;  $T_3$  8.8;  $T_4$  4.3.

Nymph (in alcohol)

*Head*: No frontal shelf. Five low, rounded tubercles on face, two below and three between the antennae. Wide, raised median carina, crossed in middle by another ridge. Occipital tubercles prominent, tapering to a blunt point. *Thorax*: Prothorax mottled black brown. Submedian tubercles, three on each side arranged as follows: the anterior tubercle is high and blunt; the posterior pair are small and unequal, the median being lower and set somewhat further forward. The submarginal tubercles, one on each side, are about two-thirds as high as the anterior submedian tubercles, but much finer. At the antero-lateral corner, a small marginal spine. Mesonotum mottled black brown. A short distance behind the anterior margin a narrow, low ridge extends from median line to antero-lateral corner; on this ridge and just below the median line is a small tubercle; on same ridge, a small tubercle is halfway distant from median to lateral margin. The principal mesonotal submedian tubercles arise from long, low, well-formed ridges, one on each side. The ridge is higher and much better defined than in *E. grandis* Eaton, and lower than in *E. glacialis glacialis* Traver. The tubercle arising from the ridge varies from one-third to one-half the height of a well developed tubercle of *E. g. glacialis*. The median posterior tubercle is larger than in *E. g. glacialis*. *Legs*: Femora dark red brown, unmodified by teeth or spines, and somewhat flattened. Tibiae red brown with dark band in center. Tarsi black in proximal portion. Claws black and with 7-8 spines. *Abdomen*: Lateral spines well developed on segments 4-9; much smaller on 3 and lacking on 2. Gills on segments 3-7. Dorsal spines very prominent; smallest and closest together on 2, larger and further apart on 3, higher and in parallel lines on 4-7; all incurved and backward bent at tips. Spines on 8 and 9 are heavier and 40% longer than those of 4-7; those on segment 8 are stouter than 9, and beset

with a few long hairs. Sternites blackish brown with vague wide pale median stripe on 1-8, and short black submedian dashes from anterior margin, and curved black dashes near lateral margins. *Tails*: Alternately black brown and yellow. *Size*: Body, 18 mm. long; tails, 12 mm.

*Holotype*: Male imago; reared from nymph collected by Helen L. Day at HANGMANS BRIDGE, EAST FORK CARSON RIVER, ALPINE COUNTY, CALIFORNIA, July 3, 1950; in collection of California Academy of Sciences, together with nymphal shuck. *Paratypes*: 1 nymph at California Academy of Sciences; 1 ♂ imago and 1 nymph in collection of George F. Edmunds, Jr.; 12 nymphs in author's collection; all topotypical.

The nymph is dull black brown, sometimes with wide pale median stripe from vextex to tergite 10. While this subspecies may prove to be only a variation of typical *E. glacialis* Traver, the adult of the latter is unknown, and comparisons of the nymphs with all the specimens of typical *E. glacialis* in the Cornell University collection show consistent differences in the height of the mesonotal tubercles. There is some difference in the height of the mesonotal tubercles in the Cornell specimens, as is true with the Carson River nymphs, but the range and the average height of the latter is much lower. Mr. George F. Edmunds, Jr., of the University of Utah has examined the material and has concurred with my belief that this should be named as a subspecies of *E. glacialis*.

The type locality of *E. glacialis* is given as Glacier National Park, Montana, and Eaton's Nymph No. 2, Revis. Monogr., p. 131, which is probably the same species, was described from Washington; this species has not been reported elsewhere. It appears that sufficient physical separation exists between *E. glacialis glacialis* and *E. glacialis carsona* to permit the subspeciation indicated.

#### WESTERN *Paraleptophlebia* HAVING NYMPHS WITH TUSKED MANDIBLES

For comparison with *P. zayante* and *P. helena*, described above, George F. Edmunds, Jr., of the University of Utah very kindly presented me with adult and nymphal specimens of *P. packii* Needham and *P. bicornuta* McDunnough. Genitalia drawings of these two longer-known species are given. Plate III, figures 1, 1a, 2, 3, 4, 5 and 5a.

#### PARALEPTOPHLEBIA CALIFORNICA Traver

(Plate III, figures 6, 7 and 8)

*Paraleptophlebia californica* Traver, 1934. Jour. Elisha Mitchell Sci. Soc. 50:195.

After examining the type material from Cornell University collection, and with additional material available, new genitalia drawings are given herewith as an aid to the identification of this species.

PARALEPTOPHLEBIA ASSOCIATA McDunnough

(Plate IV, figures 1, 2, 2a and 3)

*Leptophlebia associata* McDunnough, 1924. Canad. Ent. 56:221.

*Paraleptophlebia compar* Traver, 1934. Jour. Elisha Mitchell Sci. Soc. 50:193.

The writer has examined the paratype genitalia slide of *Paraleptophlebia associata* McDunnough No. 818 in the Canadian National Collection, referred to by Dr. James McDunnough (1924: 221) and has examined the types and paratypes of *Paraleptophlebia compar* Traver in the Cornell University collection, and believes that only one species is involved. *Leptophlebia associata* was transferred to *Paraleptophlebia* by Dr. J. R. Traver in 1934. It is the writer's belief that *P. compar* is a synonym of *P. associata*. The species is very widespread in northern California, having been collected by the author in Plumas, Alpine, Sonoma, Napa, Alameda, San Mateo, Stanislaus and Contra Costa counties, and on Waddell Creek, Santa Cruz County, the type locality of *P. compar*.

The coloration of this species, like others of this genus in California, varies considerably in fresh specimens taken from different streams, so the details of coloration are of dubious value in descriptions for species with any considerable distribution.

In the species under discussion, the reflex spurs of the penes are sometimes bent ventrally very sharply, causing them to appear quite short when viewed from below; there is considerable variation as to degree of lateral bending, the more sharply bent appearing shorter. The reflex spurs of the penes mounted on Slide 818 of the Canadian National Collection are bent ventrally and laterally quite strongly.

The published drawing of Slide 818 above referred to does not show the true appearance of the penes or spurs mounted on this slide. One important detail omitted is an easily seen "tuck" that produces a small protuberance at the end of each reflex spur. This protuberance is seen on Slide 818, all specimens from Cornell University, and all specimens collected by the present writer; it is shown on Plate IV, figs. 2 and 2a of this paper.



## PARALEPTOPHLEBIA CLARA McDunnough

(Plate IV, figures 4 and 5)

*Leptophlebia clara* McDunnough, 1933, *Canad. Ent.* 65:155.

After examining a paratype of this species from the Canadian National Collection, and with additional material of the writer's collecting available, new genitalia drawings are given herewith as an aid to identification. When the penes is cleared and mounted, the large seminal ducts are very prominent and distinctive, and are seen to be a strong dark purple. The male imago has been found to be highly variable in color.

## AMELETUS DISSITUS Eaton

(Plate V, figures 1, 3, 3a and 4)

*Ameletus dissitus* Eaton, 1885. *Trans. Linn. Soc. London, Sec. Ser. Zool.* 3:210.

On March 24, 1950, male imagoes of *Ameletus dissitus* Eaton were collected on Sage Creek, Napa County, California. The identification was made positive through the kindness of Mr. D. E. Kimmins of the British Museum (Natural History), who compared two genitalia slides from the writer's collection with the mounted genitalia of Eaton's paralectotype of *A. dissitus*. One important feature of the genitalia of this species has not been detailed in some prior drawings, and is shown on Plate V, figs. 3 and 3a; the apical ends of the stimuli are formed into sharp hooks which are easily seen and quite distinctive.

On Plate V, fig. 4, there is shown another specimen of *A. dissitus* with the apical ends of the penes fixed in a different position at the time of death; this example was collected at the same time and place as those referred to above.

## EPHEMERELLA SPINIFERA Needham

(Plate VII, figure 1)

*Ephemerella spinifera* Needham, 1927. *Ann. Ent. Soc. Amer.* 20:110.

The undescribed male adult of this species has been reared from nymphs taken from the East Fork of the Carson River, near Hangmans Bridge, Alpine County, California, July 4, 1949. Description of the male imago (in alcohol) is as follows:

*Head*: Pale yellow; median portion of face beside the median carina, and median portion of clypeus darker. Eyes light orange brown in upper portion with lower portion black. *Thorax*: Pronotum yellow brown with narrow median and lateral lines purplish-black. Mesonotum brown yellow, a somewhat darker and very wide stripe along entire median area; narrowly purple black on postero-lateral margins. Wide white bands above base of fore coxae. Basisternum of prothorax light yellow, marked with strong purple brown curved lines along antero-lateral margin and across posterior margin. Basisternum of



mesothorax white; furcisternum dark red brown with white sutures. *Legs*: All femora white at base, graduating to deep purple rose apically. Fore tibiae pink. All other leg segments white. Tarsi faintly marked with smoky. *Wings*: Faintly milky, strongly so along the costal strip. All veins dark red brown; humeral brace milky white. *Abdomen*: Tergites bright purple rose, anterior median portions pale. Tergites 4-10 with posterior margins white; marked with fine median broken black line. A wide white stripe extends full length of abdomen along pleural fold; postero-lateral corners of all tergites white. Sternites same shade as tergites; posterior margins widely white. Sternites 2-9 each with a pair of pale curved submedian dashes based on anterior margin; each sternite with a pair of small pale submedian spots mid-distant between anterior and posterior margins. *Genitalia*: Forceps purple rose. Penes black brown. *Tails*: Dark purple brown at base, lightening to white apically; joinings dark red purple. *Size*: Body 13 mm. long; forewing 15 mm.; tails 16 mm.; foreleg 12.5 mm.

#### EPHEMERELLA COGNATA Traver

(Plate VII, figure 2)

*Ephemerella cognata* Traver, 1934. J. Elisha Mitchell Sci. Soc. 50:231.

The undescribed adult male of this species has been reared from nymphs taken from San Gregorio Creek, San Mateo County, June 17, 1950; from Sage Creek in Napa County; from Sonoma Creek in Sonoma County and from Waddell Creek in Santa Cruz County, the latter being the type locality. All counties named are in California. Description of the male adult (in alcohol) is as follows:

*Head*: Blackish-brown with pale median line on vertex; clypeus and nasal carina hyaline yellow. Antennal sclerite white. *Thorax*: Pronotum, mesonotum and sternum blackish-brown. Pleural sutures paler. *Legs*: Foreleg medium brown. Middle and hind legs white, the apices of the tibiae sometimes faintly brown. *Wings*: Faintly milky, strongly so in stigmatic areas; dark brown areas at bases of wings. A long axial cord is present as in *Ephemerella tibialis* McDunnough; this cord extends almost to tip of scutellum and then projects backward .3 mm. beyond the scutellum. All veins are colorless; so completely vitreous that they are easily seen against the slight milkiess of the wings. *Abdomen*: Segments 2-7 semi-hyaline yellow green. Dorsum and sternum concolorous. Tergites with dark posterior margins, broadest in median area; fine, broken, double, dark median stripe. Sternites show ganglionic areas as white opaque and/or hyaline; small dark spots near antero-lateral corners. *Genitalia*: As shown on Plate VII, fig. 2. *Tails*: Clear hyaline white, narrowly marked with brownish red at each joining. *Size*: Body 7 mm. long; forewing 8 mm.; tails 9 mm.; foreleg 7.5 mm.

#### IRONODES LEPIDUS Traver

(Plate VII, figures 3, 4, 5 and 6; Plate VIII, figure 1)

*Ironodes lepidus* Traver, 1935. Canad. Ent. 67:35.

The undescribed nymph of this species has been associated with

the male adult through rearing, and drawings of nymphal mouth-parts are given that may be helpful in the further study of this genus. Nymphs were collected on a small tributary of Hamilton Branch, North Fork of Feather River, Plumas County, California, on May 29, 1950.

In alcohol, the entire dorsum of this nymph is dark red brown. Before each ocellus, a pale yellow spot. On the pronotum, a fine, dark raised ridge extends nearly the full width across; it is parallel to and one-third the length of the pronotum behind the anterior margin. Mesonotum vaguely marbled with lighter brown. Basisternum of prothorax outlined in dark brown on lateral and posterior margins; a small yellow brown central area. Median area of mesosternum and metasternum yellow brown; all other surfaces of sternum white. On well marked specimens, a small pale spot at the base of each submedian abdominal spine. Sternites yellow brown with dark brown lateral streaks; a pair of pale submedian oblique dashes arise from anterior margin on each sternite. Lamellate portions of gills dark red brown with central portion white to base; fibrilliform portions lavender; tracheae of gills not visible in reflected light. Legs dark red brown with black brown tarsi narrowly banded with yellow at proximal end. Anterior surfaces of femora with white area in middle, and white line extending to base; posterior surfaces with wide white stripe from base almost to apical end.

The nymphs of *I. lepidus* were found only in very fast water. Emerging at 2:00 p.m. on Hamilton Branch tributary, they crawled almost out of water on rough rock, waited for from 3 to 5 minutes, broke out of the nymphal skin, crawled to a dry portion of rock and dried the wings for up to 9 minutes before flying to low branches at the water's edge.

ISONYCHIA VELMA Needham

(Plate VIII, figures 2 and 3)

*Isonychia velma* Needham, 1932. Canad. Ent. 64:273.

The undescribed nymph has been associated with the male adult through rearing. This species is very widespread in northern California, found to date in large rivers such as the Klamath, Trinity, Russian, and Putah Creek. It has been found always in shallow, fast riffles, frequently on wood. The body of the mature nymph is as long as 20 mm. The description of the nymph follows:

Entire body an even tone of darkest yellow brown; head almost black. Basal segment of antennae very dark, as is pedicel; flagellum dark at base, paling apically. Tergites with faint, narrow pale median stripe in anterior halves; this stripe is paralleled by a submedian pale stripe on each side. Tergites and sternites with fine black lateral margins and finest black posterior margins; latter beset with fine, short spinules. Sternites with short, pale oblique streaks based on median point of anterior margin; just beyond the posterior ends of these, a series of four small pale spots, two on each side, are in line across the sternite. Gills pale gray brown with wide chitinous ridge along lower edge; an interior band of chitin across the gill one-third distant below the dorsal edge. Fore femur dark brown with wide pale apical band, and pale area in middle. Fore tibia pale with wide dark band toward proximal end. Fore tarsus black brown in proximal half and pale apically. Claws pale with small black tips. Spur at apical end of fore tibia varies from two-thirds to full length of fore tarsus; 16-20 spines on each fore tibia; 8-9 teeth on fore claw, irregularly spaced.

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